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CARBON DIOXIDE UTILIZATION IN ANIMAL TISSUES[1, 2]

By Dr. E. A. EVANS, Jr.

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IF we consider living organisms in terms of their nutritional demands upon the environment in which they live, we can place the plant with its ability to synthesize all the complex components of its structure from light energy and simple inorganic substances such as carbon dioxide, water and ammonia at one extreme and the animal with its fastidious demands for preformed dietary constituents such as vitamins, certain amino acids and certain fatty acids at the other. The carbon requirements of the plant can be satisfied completely by carbon dioxide. For animals the sources of carbon are the energy-rich organic molecules of the diet, and carbon dioxide is regarded traditionally as a metabolic end product. Experimentally, this is justified in that one can demonstrate a photosynthetic uptake of carbon dioxide in plants, while with animal tissues a continuous metabolic production of carbon dioxide is observed.

The photosynthetic process can be generally formulated:[3]

(1) $CO_2 + 2H_2A + \text{energy} \longrightarrow (CH_2O) + 2A + H_2O$
[HA is any oxidizable substance: A the oxidation product of HA]

[1] Read before the American Chemical Society at Memphis, Tennessee, on April 22, on the occasion of the conferring of the Eli Lilly and Company Award in biological chemistry for 1942.

[2] The original work reported in this paper was aided in part by grants from the John and Mary R. Markle Foundation and from the Dr. Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago.

[3] C. B. Van Niel, *Cold Spring Harbor Symp. Quant. Biol.*, 3: 138, 1935.

In the chlorophyl-containing plant-cell this becomes:

(2) $CO_2 + 4H_2O + \text{light} \longrightarrow (CH_2O) + O_2 + 2H_2O$

It would be well to reserve the term photosynthesis for this reaction, which is uniquely characterized by (1) the production of free O_2 as an end product and (2) by being the only process involving the reduction of CO_2 which results in a gain in energy by the assimilating system, since the energy for reduction has not been furnished by cellular metabolism but by activated chlorophyl.[4] The process of CO_2 reduction or more precisely of CO_2 fixation and reduction is, therefore, not the most characteristic feature, although an integral part, of the photosynthetic process.

There exist other and numerous examples of carbon dioxide utilization apart from photosynthesis. In certain non-photosynthesizing, so-called autotrophic, unicellular organisms the ability to use CO_2 as a sole source of carbon has been recognized for many years. The energy required for the reduction of CO_2 in these organisms is derived from a coupled chemical reaction and the process is termed "chemosynthetic." In 1935 the utilization of CO_2 by typical heterotrophic bacteria was demonstrated by Wood and Werkman at Iowa State.[5] While the carbon requirement of the heterotrophic bacteria can not be met by CO_2 alone, they utilize CO_2 in the metabolic reactions by which they maintain their existence.

Within the last year and a half evidence has been obtained that a non-photosynthetic utilization of CO_2 occurs also in animal cells.[6] CO_2 utilization, therefore, is a process which is of general biological occurrence.

It should be emphasized that two types of reactions are embraced by the phrase "carbon dioxide utilization." In the "dark reaction" of photosynthesis, a *fixation* of CO_2 as carboxyl groups apparently occurs,[7] *i.e.*,

$$R.H + CO_2 \rightleftharpoons R.COOH$$

A similar carboxylation or fixation of CO_2 in the carboxyl groups of the dicarboxylic acid seems to occur in animal cells. This type of reaction is to be differentiated from the true *reduction* of CO_2 that occurs in the photosynthetic conversion of CO_2 to carbohydrate, in the production of methane from CO_2 by *Methanobacterium omelianskii*[8] and in other systems. It follows, therefore, that the utilization of carbon dioxide by a given system can not be termed a reduction of CO_2 unless specific information as to the fate of the inorganic carbon is available. Both types of CO_2 utilization, fixation and reduction are of biological importance.

Recognition that CO_2 utilization occurs in animal tissues came as the result of investigations of carbohydrate metabolism. Since current attempts to interpret the importance of the process reflect this fact, some consideration of carbohydrate metabolism, particularly of the mechanism of oxidation of pyruvic acid, is pertinent to the discussion.

The work of a number of investigators has shown that the oxidative reactions by which carbohydrate is metabolized in many tissues are centered around the 4-, 5- and 6-carbon dicarboxylic acids. In pigeon breast muscle[9,10,11,12] and in pig heart muscle,[13] pyruvic acid is metabolized by the reactions of the so-called citric acid cycle. If we add malonic acid to this system the cyclic reaction stops, due to the poisoning of the enzymes responsible for the conversion of succinic acid to fumaric acid; pyruvic acid is no longer utilized and the oxygen uptake of the tissue is reduced to about 10 per cent. of its original value. These facts apply to muscle tissue alone; in liver the picture is quite different. While we can demonstrate the existence of the necessary enzymes to bring about the conversions of the citric acid cycle, the addition of sufficient malonic acid to inhibit the succinic dehydrogenase enzyme is not followed by any decrease in the utilization of pyruvic acid or oxygen as it is in muscle. At the same time citric, α-ketoglutaric and succinic acids accumulate. From this and from other facts it appears that there exists in liver a reaction by which pyruvic acid is converted into these dicarboxylic acids —a reaction that is not poisoned by malonic acid.[14] Although we are unaware of the mechanism of this reaction, we know that it involves the direct participation of carbon dioxide.

When pyruvic acid is oxidized by an animal tissue such as pigeon liver, a continuous production of carbon dioxide occurs. The fact that a portion of the carbon dioxide is being incorporated into organic molecules can only be demonstrated by the use of radioactive carbon dioxide or of the stable isotope of carbon. It was, perhaps, inevitable that the preparation of carbon isotopes suitable for use by the biologist should result in recognition of the widespread occurrence of CO_2 utilization in living tissues by various independent groups of workers. Investiga-

[4] H. Gaffron, *Biochem. Zeits.*, 292: 269, 1937.
[5] H. G. Wood and C. H. Werkman, *Jour. Bact.*, 30: 332, 1935.
[6] E. A. Evans, Jr., and L. Slotin, *J. B. C.*, 136: 301, 1940.
[7] S. Ruben, M. D. Kamen, W. Z. Hassid and D. C. Devault, SCIENCE, 90: 570, 1939; *Jour. Am. Chem. Soc.*, 62: 3443; 3450; 3451, 1940.
[8] H. A. Barker, S. Ruben and M. D. Kamen, *Proc. Nat. Acad. Sci.*, 26: 426, 1940.
[9] H. A. Krebs and W. A. Johnson, *Enzymologia*, 4: 148, 1937.
[10] H. A. Krebs and L. V. Eggleston, *B. J.*, 34: 442, 1940.
[11] H. A. Krebs, *B. J.*, 34: 460, 1940.
[12] H. A. Krebs, *B. J.*, 34: 775, 1940.
[13] D. H. Smyth, *Biochem. Jour.*, 34: 1046, 1940.
[14] E. A. Evans, Jr., *B. J.*, 34: 829, 1940.

tions from Berkeley, from Iowa State and Minnesota, from Harvard and from Chicago have contributed to the rapid development of this field.

In the propionic acid bacteria, Wood and Werkman have postulated that the utilization of CO_2 involves a condensation of CO_2 with a 3-carbon particle such as pyruvic acid to form oxaloacetic acid. This substance is then reduced to succinic acid. In experiments with radioactive carbon and the stable carbon isotope, C_{13},[15,16] the incorporation of CO_2 into succinic acid could be shown. However, the intermediate formation of oxaloacetic acid was not directly demonstrated.

If one assumes that the same reaction occurs in pigeon liver, *i.e.*, that carbon dioxide and pyruvic acid condense to form oxaloacetic acid, the mechanism of the dicarboxylic acid synthesis from pyruvate in liver could be explained by a series of reactions resembling those described for muscle: *i.e.*, the condensation of oxaloacetic and pyruvic acids to form citrate and the oxidation of this to α-ketoglutaric acid.

In experiments with a suspension of minced pigeon liver in a bicarbonate buffer containing radioactive carbon dioxide, Slotin and I[6] were able to demonstrate the utilization of carbon dioxide to form α-ketoglutaric acid. About 5 per cent. of the total radioactivity of the system, originally present as inorganic carbon dioxide, could be accounted for as this substance. All the radioactivity present in the α-ketoglutaric acid was located in the carboxyl group α to the carbonyl oxygen. On oxidation of the radioactive α-ketoglutarate with permanganate the succinic acid formed was entirely inactive[17] and the entire original radioactivity of the α-ketoglutarate was found in the carbon dioxide evolved during the oxidation. Likewise, succinic acid formed enzymically during the oxidation of pyruvate by malonate-poisoned liver was devoid of radioactivity.[17] These facts can not be reconciled with the intermediate formation of citric acid, and it is impossible that a symmetrical molecule of the type of citric acid could be intermediate in the process.

It is possible to estimate roughly from the ratio of radioactivity per milligram carbon of the medium to that of the α-ketoglutarate that about 1 carbon atom in 10 of the synthesized α-ketoglutarate is derived from the medium. Since the radioactivity is confined entirely to the carboxyl group of the α-ketoglutaric acid, the number of carbon atoms of the α-ketoglutaric acid derived from the medium can not exceed 1 in 5. Calculation of the 1 in 10 value is approximate and indicates only the order of magnitude of the synthesis. It seems probable that one mole of carbon dioxide is derived from the medium for every mole of α-ketoglutarate synthesized and that we are concerned with a stoichiometric utilization of CO_2.

Implicit in what has been said is the assumption that the appearance of radioactivity in α-ketoglutaric acid reflects the direct synthetic utilization of inorganic carbon. It is possible, however, that the radioactivity could result by a simple process of exchange between an intermediate in the reaction and carbon dioxide of the medium. That is, reactions of the type

$$CH_3C\cdot COOH \rightleftharpoons CH_3CHO + CO_2$$
$$\ddot{O}$$

$$COOH\cdot CH_2\cdot C\cdot COOH \rightleftharpoons CO_2 + CH_3C\cdot COOH$$
$$\ddot{O} \qquad\qquad\qquad\qquad\qquad\qquad \ddot{O}$$

could, by virtue of their reversibility, introduce radioactivity into the cyclic chain of chemical reactions which are occurring in the metabolizing tissue. However, estimates of the extent of such reactions are too low to account for the observed utilization of CO_2.[18,19]

Under our experimental conditions, the uptake of radioactive CO_2 by pigeon liver suspensions may involve 25 to 30 per cent. of the total radioactivity of the system. Only about 25 per cent. of the radioactivity which has been converted into organic combination can be accounted for as α-ketoglutarate. Of the non-α-ketoglutarate activity, about 25 per cent. can be released as carbon dioxide by treatment with ninhydrin or chloramine-T, suggesting the presence of isotopic carbon in the carboxyl groups of α-amino acids. Wood and Werkman,[20] using the stable carbon isotope, have shown that dicarboxylic acids such as fumaric, malic and succinic acids, and also lactic acid, contain isotopic carboxyl carbon, and these substances must account for another portion of the non-α-ketoglutarate radioactivity.

In the earlier stages of the work, a picture of the fate in pigeon liver of that portion of carbon dioxide which is concerned with pyruvate metabolism was drawn by assuming that a preliminary condensation of carbon dioxide and pyruvic acid to oxaloacetic acid occurs. By the further assumption of the reactions of the citric acid cycle it would be possible to account for the appearance of isotopic carbon in the carboxyl groups of the dicarboxylic acids. The formation of isotope-containing lactic acid could be accounted for by a reversible enolization and hydration of oxaloacetate and its decarboxylation to pyruvic acid. In substance then this would imply that the so-called citric acid cycle of muscle exists also in liver with the addition of the CO_2 utilizing reaction.

There are, however, strong objections to this scheme.

[15] S. F. Carson and S. Ruben, *Proc. Nat. Acad. Sci.*, 26: 422, 1940.

[16] H. G. Wood, C. H. Werkman, A. Hemingway and A. O. Nier, *J. B. C.*, 135: 789, 1940; 139: 365, 1941.

[17] E. A. Evans, Jr.. *Bull. Johns Hopkins Hospital*, 69: 225, 1941.

[18] E. A. Evans, Jr., and L. Slotin, *J. B. C.*, 41: 439, 1941.

[19] E. A. Evans, Jr., in "A Symposium on Respiratory Enzymes," University of Wisconsin Press, 1941.

[20] H. G. Wood, C. H. Werkman, A. Hemingway and A. O. Nier, *J. B. C.*, 142: 31, 1942.

First, there is a complete lack of experimental evidence that oxaloacetic acid is the initial product of carbon dioxide fixation. However, this substance is extremely unstable and rapidly metabolized and a final decision as to its role in carbon dioxide utilization will come in all probability only after purification of the enzyme systems involved. The second objection involves the intermediate formation of citric acid itself. I have already pointed out that the available data eliminate this substance as a possible intermediate in the formation of α-ketoglutaric acid. Wood and Werkman[20] have attempted to answer this by assuming that the reaction goes through isocitric rather than through citric acid. However, Johnson[21] has shown that in pigeon liver as well as other tissues an enzymic equilibrium is maintained between citric and isocitric acids. Until supporting data are forthcoming there seems little reason to accept this modification of the original citrate-intermediate theory.

In any event we are unquestionably concerned with a synthetic reaction in pigeon liver utilizing CO_2 and leading to the formation of the dicarboxylic acids. In so far as the general importance of the reaction is concerned, we have found that a utilization of CO_2 comparable in magnitude to that in pigeon liver occurs in rat liver and beef liver. Presumably, the reaction is of general occurrence in the liver of higher animals. In muscle, CO_2 utilization does not take place to any appreciable extent. Other tissues have not been studied.

In the intact rat, Solomon, Vennesland, Klemperer, Buchanan and Hastings[22] have shown that when radioactive $NaHCO_3$ is injected into fasting rats and lactic acid is fed at the same time, a considerable part of the radioactive carbon appears as glycogen in the liver. There is little precise information as to the manner in which lactic acid is synthesized to glycogen but it is reasonable to assume that the reaction is the reverse of the glycolytic process, *i.e.*, the breakdown of glycogen to lactic acid. This involves (Fig. 1) a series

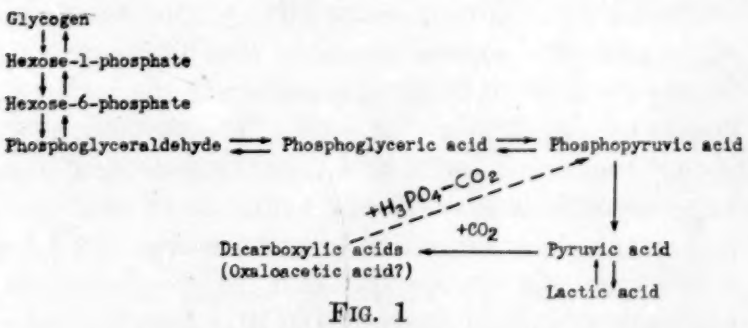

FIG. 1

of reversible reactions excluding the single step by which phosphopyruvic acid is converted into pyruvate. Under these circumstances the appearance of radioactivity in the liver glycogen being formed from lactic acid (and this happens only when there is a demonstrable synthesis of glycogen) argues for a reaction or series of reactions involving CO_2 and serving as a short circuiting mechanism around the irreversible phosphopyruvate-pyruvate step. Hastings and his co-workers have pointed out that by assuming a phosphorylation of the dicarboxylic acid formed from CO_2 and pyruvate and the subsequent breakdown of this product to phosphopyruvic acid, it would be possible to explain the incorporation of carbon dioxide in glycogen by a reversal of the known intermediate stages between glycogen and phosphopyruvic acid.

From another view-point we can regard carbon dioxide fixation as a device for the synthesis of the dicarboxylic acids which apparently play so important a catalytic role in the carbohydrate metabolism of muscle and other tissues. The reaction may serve as a source of the dicarboxylic acids (possibly transported in some other form) for those tissues incapable of their direct formation. We can see the advantage of a reaction which would result in the formation, from pyruvic and CO_2, of the catalytic agents concerned in the metabolic disposal of pyruvic acid, especially under circumstances in which large quantities of pyruvic acid were present.

However, such speculations as these may be entirely overthrown by further study. As I have pointed out previously, a considerable portion of the CO_2 utilized by pigeon liver can not be accounted for in terms of carbohydrate intermediates, although these may be the initial products. It is probable that such cellular-constituents as the purines also arise in the course of the fixation of carbon dioxide. With rat liver slices, a true synthetic utilization of carbon dioxide in the formation of urea has been known for a long time and although this reaction does not occur in pigeon tissue, the formation of other carbon-nitrogen bonds may be involved in the utilization of carbon dioxide.

The problem would be very much simplified, of course, if the carbon utilizing system could be obtained in a cell-free form. Dr. Slotin, Dr. Vennesland and I have accordingly directed our recent efforts to that end. While both minced beef liver and rat liver utilize CO_2, attempts to prepare cell-free extracts from these sources gave preparations of small and variable activity. With pigeon liver, however, we have succeeded in preparing very active cell-free carbon dioxide utilizing systems.[23] We have employed two types of preparations in our studies. The first of these was the cloudy cell-free supernatant obtained after centrifuging a suspension prepared by grinding minced pigeon liver with sand and an equal volume of ice cold phosphate buffer, pH 7.4. In these extracts there is

[21] W. A. Johnson, *B. J.*, 33: 1046, 1939.

[22] A. K. Solomon, B. Vennesland, F. W. Klemperer, J. M. Buchanan and A. B. Hastings, *J. B. C.*, 140: 171, 1941.

[23] E. A. Evans, Jr., L. Slotin and B. Vennesland, *J. B. C.*, 143: 565, 1942.

an initial rapid utilization of CO_2, followed by a slower loss of radioactivity. Apparently at least two enzymic reactions are present, one involving the uptake and the second the release of carbon dioxide.

A further simplification of the CO_2 utilizing system can be effected by using an acetone powder of pigeon liver as the starting material. This source is the most promising we have obtained for study of the initial carbon fixation reaction. Extraction of acetone dried minced pigeon liver with water or with buffered solutions yields upon centrifugation a deep-red, cell-free supernatant which shows active CO_2 uptake. In such extracts, with increasing time there is a steady increase in the amount of CO_2 taken up and it appears that the reactions leading to the release of radioactive CO_2 are either absent or inhibited. Both fumaric and pyruvic acids are necessary for the complete activity of these extracts. There is an increase in the amount of carbon dioxide utilized with increasing quantities of pyruvic acid, and we are undoubtedly concerned with a reaction involving both CO_2 and pyruvate. At intervals during the reaction we have tested for the formation of oxaloacetic acid. The results, however, were entirely negative and if oxaloacetic acid is formed during the process of pyruvate utilization by these extracts, its existence must be extremely transitory and at concentrations below those we can detect by present methods. The utilization of CO_2 proceeds to the same extent in nitrogen and carbon dioxide as in the presence of O_2 and CO_2.

When pyruvate is added to these extracts under anaerobic conditions, a slow production of CO_2 can be observed. Whether this reaction is involved in the fixation of CO_2 remains open to further investigation, but in itself it is of interest since it constitutes an example of anaerobic decarboxylation of pyruvic acid by animal tissues. The preparation of an enzyme from pig heart muscle capable of effecting the anaerobic decarboxylation of pyruvic acid was described in 1941 by Green *et al.*[24] Pigeon liver extract apparently contains a second enzyme of this type, although, unlike the pig-heart-muscle enzyme, acetyl methyl carbinol is not formed as the reaction product.

These cell-free extracts, then, readily utilize CO_2 from pigeon liver. They show increased utilization of CO_2 on the addition of pyruvic acid and of fumaric acid. The reaction proceeds anaerobically and there is no evidence of the accumulation of oxaloacetic acid.

I may be excused for presenting this brief summary of our preliminary experiments with cell-free extracts on the ground that they open the way to a purely chemical approach to the problem. It is to be hoped that the characterization and isolation of the components of such extracts will resolve the mechanism of CO_2 utilization in animal cells. The clarification that this may afford our knowledge of carbohydrate metabolism, and of the mechanism of carbon dioxide reduction in photosynthesis serves as both a stimulus and a goal.

It is necessary to modify our former ideas which contrasted the synthesis of organic molecules from CO_2 in plants to the uni-directional reverse breakdown of these molecules to CO_2 in the animal world. Rather, it is necessary to believe that the fixation and reduction of CO_2 may be as biologically important in the animal cell as it is in the plant.

[24] D. E. Green, W. W. Westerfeld, B. Vennesland and W. E. Knox., *J. B. C.*, 140: 683, 1941.

THE RECENT EXPANSION OF THE ALUMINUM INDUSTRY[1]

By T. D. JOLLY

THE ALUMINUM COMPANY OF AMERICA

UNDER present conditions, most of us have our noses so firmly pressed against our own grindstones that our range of vision doesn't extend much beyond our own jobs.

Because this is true in my own case, this will not be a scientific address on proper methods to be followed in purchasing for construction in war times, but simply a recital of our experience during the past two or three troublesome years—in other words, a case history of expansions in the aluminum industry and, in particular, in Aluminum Company of America.

Two months after the Munich conference of 1938, the company initiated a study of its ability to meet any demand which might come from Britain or France, should war suddenly break out. A six-man committee, representing various departments within the company, was appointed. That committee made frequent reports to the management as conditions changed throughout 1939. Based on these reports, and disregarding both the large stock of aluminum on hand and the apparent small requirements of the armed forces of this country, the company inaugurated an expansion program which, with the additions since made to it, calls for a capital expenditure of

[1] Address delivered before the convention of the National Association of Purchasing Agents, Waldorf-Astoria, New York, May 26, 1942.

about $250,000,000 of the company's money. This expansion is now substantially completed.

On February 12, 1940, the Russo-German economic treaty was signed, and on March the eighth we started construction of a plant to produce 30 million pounds of aluminum ingot per year. A month later, Germany invaded Denmark, and on April 16, 1940, we decided to increase our new plant to 60 million pounds capacity.

On September 1, 1940, our National Guard units mobilized, and on the third the Navy Department announced the transfer of 50 United States over-age destroyers to Britain in exchange for air bases; while on September 14 the compulsory draft bill passed. With the United States embarked on a defense program, we again increased the size of the new plant—this time to 160 million pounds capacity.

Other aluminum metal-producing plants were expanded to the limit of the power available, and two new hydro-electric power developments were started. Mining operations, ore refining and fabricating facilities kept pace with these increases and continued to expand as the defense program developed. But both funds and credit of any privately owned industry are limited, and by midsummer of 1941 it was quite obvious that no company could finance the full requirement of aluminum.

On August 19, 1941, we signed a contract with Defense Plant Corporation to design and construct at cost, but without fee or profit to the company, one ore-refining plant and three aluminum metal-producing plants. By a supplemental agreement of December 12, 1941, we agreed to build two additional metal-producing plants.

Months before any contracts were signed, we became convinced in our own minds that these additional government aluminum plants would have to be built and that we would have to build some of them. Accordingly we obligated the company for something over $16,000,000 worth of equipment to be used in their construction. This enabled us to save many weeks, and two of the metal-producing plants are now in operation; three others will come along in the very near future.

We have now started on a new program for Defense Plant Corporation. Censorship rules do not permit us to disclose the type, capacity or location of new plants, but we can say that we are building, for Defense Plant Corporation, a total of fifteen plants and that they are located in eight states.

With our own program, this gives us a total of thirty-five major projects now under way. These bring our total acreage of floor space put under roof since January 1, 1940, to 335 acres.

By May 2 of this year, we had placed 108 subcontracts for Defense Plant Corporation, only eight of which were negotiated. Four hundred bids were obtained for the hundred competitively awarded contracts, and of course there are still quite a few not closed. On May 2 we had 7,920 men engaged directly on construction and had placed 17,500 purchase orders.

Summing up: By the end of 1943, the United States production of aluminum will be approximately 2,100,000,000 pounds—six and one-half times its 1939 production. Each of several of the new plants will produce more aluminum than the entire nation made at its World War I peak—and still there will not be a pound available for civilian use.

How much is 2,100,000,000 pounds of aluminum? It is sufficient to rebuild every railroad passenger car in the United States three times a year. Or it could be utilized, were we not at war, to put a 30-piece cooking utensil set in every one of America's 34,000,000 homes, with enough metal left over to make 5,000,000 miles of aluminum transmission cable of the type used in 1936 to 1940 for the electrification of rural America.

It might help to understand the purchasing problems involved if we rather briefly review the processes employed in the production of aluminum.

We start with a mineral called bauxite, which contains about 55 per cent. aluminum oxide and less than 7 per cent. silica. The bauxite is ground to a fine powder and digested in a hot caustic solution under pressure. The aluminum hydrate is dissolved in the hot caustic liquor and passes with it through a filter press, leaving the balance of the bauxite, commonly called red mud, to go to waste disposal. The liquor is then cooled and passes into large tanks, where aluminum hydrate is precipitated. This is washed, to remove soda, thickened, then calcined and shipped to the reduction plants as alumina. This ore-refining process requires large quantities of pure water, steam, soda ash and lime, as well as two pounds of bauxite for each pound of alumina produced.

The alumina, or aluminum oxide, is reduced to metallic aluminum in the metal-producing plants in long rows of electrolytic cells. The cell consists of a steel shell lined with carbon, which serves as the cathode. Electricity is led into each cell through carbon anodes suspended from above the cells on overhead busbars.

In the operation of the cell, the aluminum oxide, dissolved in a bath of molten cryolite, is decomposed by the passage of the electric current. Cryolite is found in commercial quantities only in far-away Greenland; however, we have facilities in this country for making a synthetic material which is the chemical equivalent of natural cryolite, and we can use either

in the production of aluminum. At the present time, additional electrolyte plants are being built so that we will be entirely independent of Greenland cryolite.

The cryolite bath material is first introduced into the cell. When it has been melted by the electric current, the alumina is added to the bath and dissolved in it. The low voltage direct current separates the aluminium oxide into aluminum and oxygen. The oxygen liberated during the reaction combines with the carbon anode to form gas, which escapes, while the aluminum is deposited on the bottom of the cell where it remains as a molten layer until tapped off. When the bath becomes exhausted in alumina, more alumina is added and the cycle of operation is repeated.

In the production of one pound of aluminum, two pounds of alumina—made from four pounds of bauxite—are consumed. In addition, ten kilowatt-hours of electricity are required to separate the aluminum from the oxygen, and three quarters of a pound of carbon electrode is burned. In fact, if we take into account all the materials used in the different steps, from the mining of the ore to the manufacture of metallic aluminum, it will be found that nine pounds of raw material are required to make one pound of aluminum.

Carbon electrodes are an important item. They are made by forming a hot mixture of coal-tar pitch and calcined petroleum coke in molds under hydraulic pressure. These electrodes must then be baked to remove the volatiles from the binding material, and after cleaning they are ready for use. Such large quantities of carbon electrodes are consumed in the aluminum industry that it is necessary to provide facilities for their manufacture to supply the metal-producing plants.

The major item of consideration is, of course, electricity. To produce the 2,100,000,000 pounds of aluminum will require annually more electricity than was consumed in 1940 in 27 of the 48 states. Yes, the aluminum industry in one *day* will draw more current than a city of 60,000 homes consumes in one *year*.

This large amount of electricity means considerable planning and investment in power developments. Power comes from three sources: (1) company-owned hydro plants; (2) government-owned hydro plants; and (3) from steam and hydro plants of privately owned public utilities. For every dollar we have invested in plant and equipment at our large Tennessee Works, there is another dollar invested in the mountains in hydro plants. In addition, we are drawing from TVA there as well.

It is interesting to look back and see how conditions and purchasing problems have changed in the comparatively short time we have been engaged in this expansion program. It started before we even thought of serious shortages of materials; then came the defense program and voluntary priorities on some materials. Then, as defense plans developed, so did mandatory priorities. And I might add, we can well appreciate the meaning of priorities, since the aluminum industry was the first to be placed on priorities! Then came allocations, restrictions and prohibitions on the use of materials, and frozen price levels.

In the case of our company expansion program, it was cheaper and quicker to expand existing plants and, where possible, build new plants near old ones in order to utilize the supervision and experience of our existing personnel in developing new operating organizations. We are building to-day an aluminum industry seven times the size of our peacetime industry and that spreads our personnel pretty thin.

The first Defense Plant Corporation sites were selected four to six months before Pearl Harbor. OPM recommended the locations after a study of markets, source of raw material, power and labor. The actual sites were selected on the basis of accessibility, foundation conditions and surroundings.

Because of the enormous quantity of power required and the shortage of materials, it has been necessary to locate the new plants so as to consume the least possible amount of copper in transmission lines. This reverses the old theory of locating aluminum plants in sparsely settled areas where a plentiful supply of power is available at low prices because there are few if any customers. Under present conditions, there is a greater amount of power available in the large metropolitan districts than in any other.

Since it has been officially announced, it is all right to say that the largest aluminum metal-producing plant in the country is now under construction about ten minutes by automobile from this hotel (Waldorf-Astoria, New York City). A unique feature of this plant will be its pure silver busbar and silver-wound transformers. The Conservation Branch of WPB solved our copper purchasing problem by arranging this substitution.

The government-owned metal-producing plants require about 36,000 tons of copper busbar. If we add the requirements for light and power wiring, motors and other miscellaneous uses, this becomes entirely too much copper for these days of heavy military demand. On the new program, the United States Treasury will loan DPC silver from the vaults at West Point. It will be fabricated by the copper companies and shipped to us ready to install. Present plans call for the use of about 13,000 tons for heavy busbar. At

the end of the emergency it is to be returned to the Treasury.

Before we started building for the government, we decided that it would be necessary to standardize buildings and equipment as much as possible in order to complete our construction and obtain production as soon as possible. This has paid big dividends, not only on our work, but has spread out and benefited many people who never heard of us. For example, we have purchased from one crane manufacturer since January 1, 1940, one hundred and seventy-five cranes, all of the same span and capacity. The only change in specifications for these cranes was on a few motors, which had to be 50 cycle. The crane builder was able to set up a production line system and claims 50 per cent. more efficiency than if he had the shop filled with miscellaneous specification cranes. The foundries supplying castings and all the other suppliers were able to produce more because of the duplication.

We had 72 buildings from the same shop drawings and many other duplications, but the most interesting one is in one of the powerhouses. At this plant, we were being supplied with natural gas at a very low price. No amount of standardization will obtain quick delivery of 35,000-kw. steam-driven turbo-generators. We were to be supplied with temporary power until we could get a steam power station in operation, but because of the long delivery on steam power equipment and the need for a quick source of power, other arrangements had to be made.

We are installing 60 gas engines, each driving a 750-kw. generator, and 18 equipped with 2,250-kw. generators. These are direct current generators and the power is transmitted directly to the production line. The conventional procedure is to convert A.C. to D.C. by means of mercury arc rectifiers. The elimination of this equipment makes the price of the gas-engine power compare favorably with that from other sources, and with low-priced gas we believe it will be a very economical installation, in spite of the large number of units required.

Every operation required for each construction job is scheduled before the job is started. This requires careful planning to have each unit arrive at the proper time for installation when needed. The aluminum reduction plants can not operate without alumina, carbon electrodes or electrolyte. As we are building plants to produce all three of these, the three types of plants must be kept in step in order to obtain the maximum aluminum production.

To correlate the efforts of the purchasing, engineering and construction departments to keep their jobs on schedule, we have set up a coordinating department in the general office. This department has copies of all schedules, purchase orders and weekly construction reports. In each of our sales offices we have selected a veteran salesman as a regional coordinator, and he has available to him, on a first demand duty basis, the services of each of the other salesmen in his office. This gives us speedy person-to-person contact with our suppliers.

The coordinator's office does not assume the prerogatives and responsibilities of the purchasing department. It merely acts for the responsible buyer and relieves him from the duty of following up his purchases. It works with the general construction superintendent to have needed materials and equipment on the job when required.

This is not an expediting department. It is not its job to worry suppliers into making shipments. Its duty is to help suppliers obtain materials from their suppliers, and sometimes the suppliers of their suppliers. It is a cooperative organization and no small part of its work is with the priority division.

At first our priority certificates were handled through one man. This was more or less a spare-time job, but as the number of forms and reports increased, so did the priority division, until at present it consists of sixteen employees. In addition to handling our own priority problems, this division is ready and anxious to render any possible assistance to our suppliers.

I was drafted by the committee, over my protest, to fill this space on the program. In these days of censorship, it is hard to make a story interesting, and with priorities, allocations and prohibited uses of materials, it is difficult to give any information regarding purchasing for construction which would be of value to a purchasing agent. If I have stressed what my own organization is doing to the point where it may seem boastful, my apologies for wasting your time.

There is, however, one thought I would like to leave with you. Aside from our operating expenditures, we will have spent for construction from January 1, 1940, to the middle of 1943, just about 600 million dollars. We have not yet been seriously behind schedule and have been ahead in some cases. No organization the size of ours could have handled this work without the cooperation of every one connected with it. Engineering, purchasing, construction, operating, coordinating and priority divisions all feel that it is their job. Every one from the blueprint boy up is anxious to see the schedules kept and takes personal pride in beating them. We have always had a purchasing policy of fair treatment to suppliers, and it is paying big dividends under to-day's rather difficult conditions, as some of our suppliers are as anxious as we are to keep our jobs up to date.

SCIENTIFIC EVENTS

DEATHS AND MEMORIALS

DR. HENRY DWIGHT CHAPIN, emeritus professor of pediatrics of the New York Post-Graduate Medical School, Columbia University, died on June 27, at the age of eighty-five years.

FRANK D. PAINE, professor of general engineering at Iowa State College and head of the department, died on June 30, at the age of fifty-six years. Besides organizing his department, he had worked out the engineering placement system for the college. From 1938 to 1942 he was mayor of Ames.

PROFESSOR EMERITUS CHARLES EDWIN ROGERS, for thirty-five years head of the department of civil engineering at Trinity College, Connecticut, died on June 30, at the age of sixty-eight years.

DR. MAXIMILIAN J. HUBENY, of Chicago, director of the x-ray department of the Cook County Hospital, died on July 2, at the age of sixty-one years.

DR. ARTHUR B. WYSE, assistant astronomer in the Lick Observatory, was killed in the blimp accident which occurred off the New Jersey coast on the evening of June 8. Since December, Dr. Wyse had been engaged in research at the Naval radio and sound laboratory in San Diego, and at the time of his death was on a mission for the Navy. He was thirty-three years of age.

THE Royal Society, London, will, if circumstances permit, celebrate its anniversary meeting on November 30, the tercentenary of the birth of Sir James Newton. The program, which will be a modest one owing to the war, is to include three lectures, to be delivered in the headquarters of the society at Burlington House. They will be "Newton and the Science of His Age," Dr. E. N. da C. Andrade, Quain professor of physics, University of London; "Newton as an Experimenter" (with demonstrations), Baron Rayleigh, emeritus professor of physics of the Imperial College of Science and Technology; and "Newton and the Science of To-day," Sir James Jeans, professor of astronomy in the Royal Institution of Great Britain.

RESEARCH AT THE UNIVERSITY OF ILLINOIS

STATISTICS made public by Comptroller Lloyd Morey, of the University of Illinois, show that in the last five years private organizations have given the university $1,337,937 to be used for research work. For the 1941–42 fiscal year, which ended on June 30, the sum of $343,340 was received. The annual gifts for research have increased more than 59 per cent. in the five years from 1938 to 1942.

At the present time, it is stated, more than a hundred firms and organizations are financing more than a hundred and fifty cooperative research projects now under way. These are in addition to the research programs and activities financed from the income of the university. The university terms as "cooperative projects" those where the industry or other agency pays for the workers, materials and any new equipment needed and the university provides quarters, equipment on hand and skilled supervision. Every such activity is covered by a definite contract approved by the board of trustees. Not only does this contract state the exact amount of funds to be given the university and outline the nature of the investigation, but it also provides that the university shall have full control of the investigation and shall have exclusive right to publish the results in official university publications.

The gifts provide funds for specific research on a scale which tax funds could not provide. Among them are fourteen government projects of a military nature—the only activities in the whole group whose results are kept secret for the present.

The following are given as among research projects completed or now in progress at the university:

Solution of a problem facing the food industry was financed by General Foods Corporation. At the expense of that company the university carried on studies to develop a superior strain of white corn hybrids as a future source of supply for higher quality hominy and grits. Another food company, Standard Brands, has been financing a study in the College of Medicine of the effect of yeast on the digestive tract. The Corn Products Refining Company is paying for researches on the digestibility of gluten feed.

The largest single donor this year is the Rockefeller Foundation, whose allotment of nearly $40,000 is being used for studies of amino acids, the development of neurology and neurosurgery, experiments in teaching psychiatry and the spectroscopic analysis of water.

The Carnegie Corporation is financing dental research and a study of libraries. The American Medical Association is backing studies of bacteria, proteins and other subjects.

The study of home heating is now being financed by three manufacturers' organizations in this field.

Another project, which has been going on for more than twenty years, is a study of railroad rails financed by the Association of American Railways and the Carnegie-Illinois Steel Company which in turn represents the Rail Manufacturers' Technical Committee. The results of this study have practically eliminated breakage of rails in service, greatly increasing the safety of railway travel. These same groups also are among backers of

tests of railway wheels and railway brakes. Both State and Federal Governments are financing research on bridges, bridge slabs and other problems of highways. The United States Navy financed a research project involving welded and riveted joints.

The Enamel Utensil Manufacturers' Association has financed a research project to set up standards for enamelware products. The standards arrived at recently already have been adopted by the Army Quartermaster Corps and other war agencies.

Among other projects, the Kellogg Company is supporting a study of "all bran"; the A. E. Staley Company a research into production of industrial oil from soybeans, other new soybean uses and sweetening agents derived from corn; the Monsanto Chemical Company, a study of insecticides; and the Illinois Clay Products Company, a study of bonding clay properties.

HANDBOOK FOR PHYSICIANS ON INDUSTRIAL HEALTH AND MEDICINE IN WAR INDUSTRIES

UPON the recommendation of the Committee on Industrial Medicine of the National Research Council, the Division of Industrial Hygiene, National Institute of Health, is preparing a manual on "Industrial Hygiene and Medical Service in the War Industries."

The publication is intended for wide distribution among industrial physicians and the general medical profession.

The recommendation of the National Research Council was endorsed by the Health and Medical Committee, and has been approved by Federal Security Administrator Paul V. McNutt and Surgeon General Thomas Parran of the U. S. Public Health Service.

The resolution submitted by the Committee on Industrial Medicine, Division of Medical Sciences, National Research Council, follows:

The change-over of industry to the manufacture of war materials is resulting in modifications of occupational health hazards, the introduction of new occupational disease exposures and certain variations in the industrial medical procedures. The following are illustrative:

1. There is increased usage of cutting oils, compounds and chemicals, many of which are capable of causing the industrial dermatoses.
2. Grinding operations have multiplied and these entail exposures to aluminum oxide, silicon carbide, and other grinding materials. While the dusts from grinding operations have not been regarded as harmful to health, disabilities occurring in workers so exposed are coming to be regarded as compensatable.
3. Shot blast operations are being replaced by sand blasting, and new installations of this nature are consistently using sand.
4. In an effort to speed up pickling operations, there is a tendency to increase the concentrations of acids in the pickling tanks, with consequently more contamination of the air with fine droplets of the acids.
5. Solvents are being more widely used and certain of the newer ones are purported to be non-toxic. Inasmuch as most of them are in the chlorinated hydrocarbon group of chemicals, they can be assumed to be more or less toxic.
6. Paint spraying operations are being modified, requiring radical readjustments in ventilation procedures.
7. There is a tendency toward longer working hours and, consequently, longer hours of exposure to harmful materials and shorter periods of recuperation.
8. It is becoming more and more necessary to employ women, older men and young men who are not eligible for military service, many of whom require selective placement, which is a function of the plant medical service.
9. It is necessary that the medical service in the war industries be integrated with the emergency medical service of civilian defense. Details necessary to this objective are not understood by the industrial physicians as yet.

In order that industrial physicians and the general medical profession, when called upon by industry, will be more adequately prepared to protect the health of the workers in the war industries,

Be it, therefore, *Resolved:* That the Committee on Industrial Medicine of the National Research Council recommends the preparation of a brochure or special article on "Industrial Hygiene and Medical Service in the War Industries" for wide distribution among the medical profession, and that this brochure be prepared by the Division of Industrial Hygiene, National Institute of Health of the U. S. Public Health Service.

The brochure will be prepared by the full-time and consultant professional staff of the Division of Industrial Hygiene, under the general editorship of Dr. William M. Gafafer, chief of the statistical unit of the division. Important subjects for discussion include: toxicity and potential dangers of organic and inorganic substances in the war industries; occupational skin diseases in war industries; engineering control; industrial medical services; nursing in industry; dental services; fatigue; women in industry; medical control of respiratory diseases; nutrition in war industries; available governmental industrial hygiene services; and integration of plant and community emergency medical services. The brochure will probably cover about 300 pages.

GIFTS AND BEQUESTS TO MUSEUMS

ACCORDING to *Museum News,* gifts and bequests to fourteen selected museums studied by John Price Jones showed that between 1930 and 1939 the low point was the year 1939 in which the total was $917,000, the first time that it had fallen below a million since 1933, when the total was $925,000 (MN, January 1, 1941). In the 20 years, 1920–1939 inclusive, the fourteen museums received altogether $48,-

363,000. The totals in the two decades, 1920–29 and 1930–39, were $22,665,000 and $25,598,000. Five of these museums received nearly 95 per cent. of the total, the American Museum of Natural History (32.19 per cent.), the Metropolitan Museum of Art (34.82 per cent.), the Franklin Institute (11.59 per cent.), the Cleveland Museum of Art (10.6 per cent.), and the Dayton Art Institute (5.58 per cent.). Other museums represented in the study were: the Charleston Museum, the Chicago Academy of Sciences, the Children's Museum of Boston, the City Art Museum of St. Louis, the Colorado Museum of Natural History, the Museum of Fine Arts of Boston, the Natural History Museum of San Diego, the Seattle Art Museum, the Virginia Museum of Fine Arts and the Museum of Fine Arts of Houston. Totals for the years 1935 to 1939, inclusive, are $1,807,000, $1,764,000, $2,279,000, $1,111,000 and $917,000. Although the last three years for which figures are available show a downward trend, the report indicates that new causes for giving, the rise in national income and other factors are reasons for a favorable outlook for general philanthropic giving. The study has been published in the Yearbook of Philanthropy, 1941–42, a 148-page volume published by John Price Jones.

SCIENTIFIC POSITIONS UNDER THE GOVERNMENT

IN the mobilization of manpower for the Government war program there is a continuing call for scientifically and technically trained men and women. The demand is urgent for physicists, metallurgists and chemists.

The Civil Service Commission has recently modified the requirements to allow college teaching to be offered as professional experience. In the case of physicists, high-school and preparatory and trade-school teaching of physics may also be considered professional experience. The requirements now are:

A four-year college course leading to a bachelor's degree, with major study in the field for which application is made, or in closely allied subjects, plus two years—for the $2,600 grade—of professional experience (which may include college teaching) or appropriate graduate study or a combination of the two. Additional experience will be required for the higher grades, commensurate with the grade. The salaries range from $2,600 for the assistant grade to $5,600 for the principal grade.

There is no maximum age limit. There is also no "recency" clause with respect to education or experience.

Although many of the metallurgical positions require field work, involving outdoor duties for which men will be needed, it is expected that there will also be an opportunity for a number of women. There is an excellent opportunity for women physicists and chemists.

No deadline is set for applying for these positions, but persons who are available and qualified are urged to apply at once. The announcement with the application forms may be obtained at any first- or second-class post office or from the U. S. Civil Service Commission, Washington, D. C. Applications should be filed with the commission's Washington office.

APPOINTMENTS AND PROMOTIONS AT THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

THE Board of Scientific Directors of the Rockefeller Institute for Medical Research announces the following appointments and promotions on the scientific staff to take effect on or after July 1, 1942:

Promotions:

Associate to Associate Member: Dr. Charles L. Hoagland, Dr. John G. Kidd, Dr. Rebecca C. Lancefield and Dr. Joseph E. Smadel.

Assistant to Associate: Dr. Jorge Folch-Pi, Dr. Rollin D. Hotchkiss and Dr. Henry A. Schroeder.

Fellow to Assistant: Dr. Ralph P. Elrod, Dr. Claude A. Knight, Jr., Dr. Thomas Laskaris and Dr. R. Walter Schlesinger.

New appointments:

Assistants: Dr. Francis Binkley, Dr. Lester O. Krampitz, Dr. Raymond E. Mezera, Dr. Mark A. Stahmann and Dr. Frederick C. Uhle.

AWARD TO DR. HOWE OF THE MEDAL OF THE SOCIETY OF CHEMICAL INDUSTRY

DR. HARRISON E. HOWE, of Washington, D. C., editor of *Industrial and Engineering Chemistry,* a publication of the American Chemical Society, has been awarded the medal of the Society of Chemical Industry for 1942.

Given annually since 1920 to "a person making a valuable application of chemical research to industry," Dr. Howe will receive the award and deliver an acceptance address at a joint meeting of the American Section of the Society of Chemical Industry and the New York Section of the American Chemical Society in New York City on November 6.

Dr. Howe, who is chairman of the advisory committee of the Chemical Section of the War Production Board and a colonel in Reserves of the Chemical Warfare Service, was born in Georgetown, Ky., on December 15, 1881. He received the bachelor of science degree from Earlham College in 1901, and did graduate work at the University of Michigan. He holds honorary degrees from the University of Rochester, Southern College, Rose Polytechnic Institute and the South Dakota State School of Mines.

He is chairman of the Division of Research Exten-

sion of the National Research Council and of the Advisory Committee on Miscellaneous Materials of the National Academy of Sciences and the National Research Council. He is a former treasurer of the American Engineering Council and during the first World War was consultant in the Nitrate Division of Army Ordnance. He is a member of the Advisory Committee of the Lalor Foundation, a national councilor of Purdue Research Foundation and a fellow of the American Association for the Advancement of Science. He is also director of the American Chemical Society News Service and a trustee of Science Service.

Before becoming editor of *Industrial and Engineering Chemistry* in 1921, Dr. Howe was associated with Arthur D. Little, Ltd., Montreal, Canada, and Arthur D. Little, Inc., Cambridge, Mass. He also was associated with the Bausch and Lomb Optical Company, Rochester, N. Y., from 1904 to 1916, and was chemist of the Sanilac Sugar Refining Company, from 1902 to 1904. He is the editor of the series of "Technological Monographs" of the American Chemical Society, the author of "The New Stone Age," "Profitable Science in Industry" and other publications and magazine articles.

The 1941 medalist was Dr. Elmer K. Bolton, of E. I. du Pont de Nemours and Company. Other recipients of the award include: Robert E. Wilson, J. V. N. Dorr, Evan J. Crane, Walter S. Landis, Edward R. Weidlein, F. J. Metzger, James G. Vail, George L. Clark, L. V. Redman, Per K. Frolich, Bradley Stoughton, Harold J. Rose, Dr. Charles R. Downs, E. R. Berry, B. D. Saklatwalla, W. H. Fulweiler and Allen Rogers.

SCIENTIFIC NOTES AND NEWS

DR. F. C. KOCH, Frank P. Hixon distinguished service professor of biochemistry emeritus of the University of Chicago, has received the Squibb Award of $1,000, established in 1939 to encourage investigations in endocrinology. The award is administered by the Association for the Study of Internal Secretions and was presented to Dr. Koch on June 8 at the annual dinner at the Atlantic City meeting of the association.

DR. JAMES W. WATTS, associate professor of neurosurgery at the George Washington University School of Medicine, was presented on May 4 with the John Horsley Memorial Prize in medicine of $600 for his paper on "Psychosurgery," written in association with Dr. Walter Freeman, of Washington.

THE William Herbert Medal, awarded annually by the American Amaryllis Society "for outstanding contributions toward the advancement of the amaryllids," has been awarded to Professor Abilio Fernandes, of the University of Coimbra, Portugal, for his researches on the karyo-cytology and taxonomy of the Genus *Narcissus*.

DR. L. PIERCE ANTHONY, editor of the *Journal of the American Dental Association*, has been awarded the William Jarvice Fellowship Medal of the Dental Society of the State of New York. This award, established in 1905, is made "for distinguished services to the science and art of dentistry."

IT is reported in *Nature* that the council of the Institution of Mechanical Engineers has awarded the James Watt International Medal to A. G. M. Michell, of Melbourne, on the nomination of the Institution of Engineers, Australia, the South African Institution of Engineers and the Engineering Institute of Canada. The medal was founded by the institution in 1936 to commemorate the bicentenary of the birth of James Watt on January 19, 1736, and is awarded every two years to an engineer of any nationality who is deemed worthy of the highest award that the institution can bestow.

MEMBERS of the Maryland State Department of Health gave a dinner on May 15 in honor of Dr. James Hall Mason Knox, Jr., to mark his retirement as chief of the bureau of child hygiene of the department.

HOWARD K. GLOYD, director of the Museum of Natural History of the Chicago Academy of Sciences, has received the honorary degree of doctor of science from Ottawa University.

THE honorary degree of doctor of science was conferred at the one hundred and seventeenth annual commencement of Jefferson College, Philadelphia, on Harris Peyton Mosher, emeritus professor of laryngology and otology of the Harvard Medical School.

DR. JAMES MONTROSE DUNCAN OLMSTED, professor of physiology at the University of California at Berkeley, received at commencement the degree of doctor of science from Middlebury College, Vermont, just thirty-five years after he received his bachelor of arts degree there. During his visit to the college, he gave the annual Phi Beta Kappa lecture to the students, his subject being "The Place of Physiology in a University Curriculum."

THE officers, executive committee and members of the Division of Geology and Geography, National Research Council, for the year July 1, 1942, to June 30, 1943, are as follows: *Chairman*, Walter H.

Bucher; *Vice-Chairman,* Richard Hartshorne; *Executive Committee,* Walter H. Bucher, Richard Hartshorne, G. Arthur Cooper, A. I. Levorsen, T. S. Lovering, Richard J. Russell; *Representatives of Societies,* Wilmot H. Bradley and T. S. Lovering—Geological Society of America; Paul F. Kerr—Mineralogical Society of America; G. Arthur Cooper—Paleontological Society; Richard Hartshorne and Richard J. Russell—Association of American Geographers; Elizabeth T. Platt—American Geographical Society; Wilbur S. Burbank—Society of Economic Geologists; A. I. Levorsen—American Association of Petroleum Geologists; George W. Morey—American Ceramic Society; *Members at Large:* Ralph H. Brown, Walter H. Bucher and Joseph T. Singewald, Jr.

FOSTER D. SNELL, of Foster D. Snell, Inc., has been elected chairman of the American Section of the Society of Chemical Industry for 1942–43. Norman A. Shepard is vice-chairman; Cyril S. Kimball, honorary secretary, and J. W. H. Randall, honorary treasurer.

OFFICERS of the British Institute of Physics, to take office on October 1, are: *President,* Sir Lawrence Bragg; *Vice-presidents,* Dr. W. Makower and T. Smith; *Honorary Treasurer,* Major C. E. S. Phillips; *Honorary Secretary,* Professor J. A. Crowther; *Ordinary Members of the Board,* Professor J. Chadwick, Professor J. D. Cockcroft, D. C. Gall and E. B. Wedmore.

AT the anniversary meeting of the Linnean Society of London held on May 28, the following were elected officers for the year 1942–43: *President,* Dr. E. S. Russell; *Treasurer,* Major F. C. Stern; *Deputy Treasurer,* Dr. B. Barnes; *Secretaries,* I. H. Burkill (botany) and Dr. Malcolm Smith (zoology). Members of the council are Dr. G. S. Carter, Dr. F. C. Fraser, C. C. Hentschel, Dr. N. A. Mackintosh and Dr. R. Melville.

DR. EARLE RAYMOND HEDRICK, since 1924 professor of mathematics at the University of California at Los Angeles and for the past five years vice-president of the university, retired on July 1. He has reached the age of sixty-six years, at which retirement from administrative positions is required. He will continue in academic work. No successor to Dr. Hedrick has been chosen. President Robert G. Sproul announced that he would devote an increasing amount of his time to the university at Los Angeles until a selection is made.

DR. JOSEPH C. HINSEY, professor and head of the department of anatomy at Cornell University Medical College and for the past six months acting dean, has been appointed dean of the college. He succeeds Dr. William S. Ladd, who had been dean since 1931 but retired recently for reasons of health. Dr. Ladd remains as professor of clinical medicine.

DR. FELIX ADLER and Dr. Richard P. Feynman have been appointed visiting assistant professors of physics at the University of Wisconsin for 1942–43.

JOHN M. COAN, formerly stress analyst with the Glenn L. Martin Company, has been named assistant professor of aeronautical engineering at Iowa State College. He will be in charge of work in airplane structure and design.

REGINALD S. DEAN, chief engineer of the Metallurgical Division, U. S. Bureau of Mines, has been appointed director of the bureau.

DR. ANDREY AVINOFF, director of the Carnegie Museum, Pittsburgh, has been elected a member of the board of trustees of the American Museum of Natural History.

ASSISTANT PROFESSOR L. P. BIEFELD, of the department of chemistry of Purdue University, has resigned to become associated with the Chemical Engineering Laboratory of the Owens-Corning Fiberglas Corporation at Newark, Ohio.

MAURICE HOLLAND, formerly director of the Division of Engineering and Industrial Research of the National Research Council, with offices in New York City, has been appointed industrial research adviser to the F. W. Dodge Corporation.

DR. J. E. COPENHAVER, for sixteen years a member of the faculty at the University of South Carolina, has resigned to accept a position with Conoco Products Company.

P. C. SANDRETTO, superintendent of the communications laboratory of the United Air Lines in Chicago, has been given leave of absence to become major in the Communications Directorate of the Army Air Forces at Washington.

DR. W. J. HAMILTON, JR., associate professor of zoology at Cornell University, has been commissioned a captain in the Sanitary Corps of the Army. He is now stationed at Fort Dix, N. J.

ANNOUNCEMENT is made that the fifty-sixth annual convention of the Association of Land-Grant Colleges and Universities will be held in Chicago from November 16 to 18. Preconvention events from November 12 to 15 are also scheduled.

THE next annual meeting of the Midwest Museums Conference of the American Association of Museums will be held on October 16 and 17, at the State Museum of Illinois at Springfield.

A COURSE dealing with the role physical science has played in modern life will be introduced next semester in the department of chemistry at the Penn-

sylvania State College. It will be conducted by Dr. Frank C. Whitmore, dean of the School of Chemistry and Physics. The course will be open to all students and will include lectures on the effect of scientific discoveries on the law of supply and demand, on the development of the machine age, on the growing of food, on the development of synthetic fabrics, on war materials and on our understanding of the universe.

COLIN C. SANBORN, curator of mammals of Field Museum of Natural History, has returned to Chicago after nearly nine months of zoological collecting in Peru. He obtained some four hundred specimens of mammals, approximately nine hundred reptiles, three hundred fishes, a hundred birds and numerous insects. A large part of these were successfully shipped to the museum through the submarine zone prior to January; the balance of the collections are temporarily stored at Callao, awaiting favorable shipping conditions. The collections, together with previous collections, give Field Museum the largest representation of the fauna of southern Peru ever brought out of that country. The Peruvian Government, the University of San Marcos at Lima and the Museo Javier Prado connected with the university gave their hearty cooperation. Field Museum will continue to make a specialty of the zoology of Peru and will have the collaboration of the Peruvian institutions in its research projects. Enrique Zuniga, a member of the staff of the Javier Prado Museum, spent several months with Mr. Sanborn in the field, collecting specimens on the southern coast of Peru, in the mountains up to elevations of 16,000 feet and in the jungles of the eastern part of the country.

CONSTRUCTION of the new $750,000 School of Public Health at the University of Michigan has begun. The new unit is located on a hill opposite the observatory and immediately south of the University Hospital group. The west section will be three stories high and contain the principal classrooms, offices, library, auditorium and lounge. Eastward there will extend two wings, each two stories high, to house laboratories and research facilities. The east section will provide facilities for normal animals on the first floor and medium preparations and glassware services on the second floor. On the first floor will be offices and workrooms designed for the teaching of physiologic hygiene and maternal, infant and school health and accommodations for the study of virus diseases. The north wing of the first floor will be assigned to industrial health, with a large laboratory for studies in environmental health, research rooms for industrial toxicology, chemical laboratory and control chambers for studies on human subjects. The second floor will accommodate facilities for health education, museums, public health laboratory practice, public health nursing, laboratories for biostatistics and public health engineering. The third floor will contain classrooms and seminars for graduate and postgraduate instruction. The Rockefeller and W. K. Kellogg Foundations have made most of the money available for construction of the unit.

MATURE men who have held responsible positions in non-essential industries and who have been displaced because of priorities will be eligible for a specially designed tuition-free course in production management at the New York University College of Engineering. The course will begin on July 20 and will be underwritten by the U. S. Office of Education under its engineering, science and management war training program. It will be offered for an eight-week period and will meet seven hours a day.

THE National Institute of Hygiene, which was recently founded in Paris, will consist, according to *Nature,* of four departments devoted respectively to epidemiology, general hygiene, problems of nutrition and social diseases (cancer, syphilis, tuberculosis and alcoholism). Each department will be provided with laboratories. The institute will be under the authority of the State Secretary for Family and Health. A National Institute for Social Insurance has also been founded in Paris and will be under the authority of the State Secretary of Labor.

IT is reported that during recent air attacks on Exeter, certain parts of University College were damaged. Some damage was done to the botany laboratories, the office building and the handicraft center were completely burned out, considerable damage was done to the new library and two halls of residence. All the glasshouses, potting sheds, storehouses, etc., on the college estate were destroyed.

De Standaard, Amsterdam, of March 24, as quoted in the *Journal* of the American Medical Association, reported that the burgomaster of The Hague has ordered that two gardens are to be devoted to the cultivation of medicinal herbs. One is to be at the Duinlaan near Kijkduin and the other between the Schenk and the railway to Leiden. Medicinal herbs will be grown which once had to be imported. The total area given over to this cultivation is to be about 40 hectares (100 acres).

IT is reported in *Nature* that, as from the commencement of next session, the name of the British Meter and Instrument Section of the Institution of Electrical Engineers will be altered to British Measurements Section. The section will include within its scope all matters relating to electrical measurement and control, the design and application of the apparatus and the materials employed in connection with them.

DISCUSSION

STEM GALLS OF SUGAR-CANE INDUCED WITH INSECT EXTRACTS

STEM galls of sugar-cane have been produced, for the first time, by artificial inoculations (with insect extracts) and evidence is presented indicating that the stimulus to gall formation is chemical in nature.

In 1936 adults of the green leafhopper, *Draculacephala mollipes,* were collected from cane plants and macerated in a mortar with a pestle in the presence of a small amount of distilled water. The concentration of the final insect extract was 1.5 cc of distilled water per insect. With a hypodermic needle, sugar-cane plants, three months of age, and growing in a complete nutrient solution, were inoculated below the growing point with the extract. One month later well-developed galls had developed on the young internodes of the inoculated plants. The control plants remained normal. To date stem galls have been produced by this same procedure on the following sugar-cane varieties; POJ 2878, H 109 and 32–8560.

In recent studies (1941) galls have been produced with an extract prepared, as described above, from adults of the corn leafhopper, *Perigrinus maidis,* and the pink sugar-cane mealybug, *Trionymus sacchari.* It was also shown that stem galls developed when extracts prepared from the corn and green leafhoppers were sterilized at 15 pounds steam pressure for 20 minutes, thus indicating that the stimulus to gall formation is chemical rather than biological in nature. It is possible that insects carry certain growth-promoting substances which when injected into plants during their feeding result in gall formation.

In these studies from 40 to 85 per cent. of the stalks injected with the sterilized and unsterilized insect extracts developed galls. In one series of inoculations stem galls were detected 12 days after the injections were made with the sterilized and unsterilized extracts. At the end of from 4 to 6 weeks the galls were well developed.

The galls, whether occurring naturally or from artificial inoculations, are at first small, watery blisters followed by raised translucent excrescences appearing on the young stalk tissue near the growing point. Later some of the galls develop into adventitious buds which give rise to shoot proliferation, while others develop into masses of irregular outgrowths assuming various shapes and sizes with no definite organization. In some instances the galls are exceptionally large and later develop enlarged buds and shoots.

There are two definite effects on cane plants inoculated with insect extracts: (1) the buds on the stalk in the region where the injections are made become stimulated and produce a rapid growth, and (2) stem galls develop on the meristematic tissue of the cane stalk. Shoots from stimulated buds have been rooted on the parent plant, separated therefrom and planted in the soil; shoots from adventitious buds arising from artificially produced stem galls are being treated in a similar manner. In the case of the latter certain shoots develop from greatly enlarged galls and manifest a marked stimulation when compared with normal shoot development. The resulting growth is being critically studied for growth, vigor and chromosome differences from the parent plant. This technique may afford one approach in securing polyploid plants in sugar-cane. It is conceivable that insects may play an important role in polyploidy occurring in nature.

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INDIVIDUAL SPECIFICITY OF DOG SERUM AND PLASMA

IN the course of a search for the hypothetical toxic factor responsible for increased capillary permeability characteristic of traumatic shock, it was noted that 0.2 cc of fresh serum or heparinized plasma obtained from normal, mongrel dogs, unselected as to breed and sex, always caused an increase in capillary permeability when injected intracutaneously into other dogs but not when injected into themselves. This increase in capillary permeability was demonstrated by the diffusion of the blue dye T–1824 into the area into which the serum or plasma had been injected. The dogs did not react to their own serum or plasma while they did to the same materials from other dogs. The intensity of the reaction varied in the different dogs. In one instance no marked increase in permeability was observed. In another, it was observed only with the material from two of the five dogs. In a third it was observed simply with the serum and not when the plasma was used.

We are indebted to Professor Stuart Mudd for pointing out to us the importance of this observation, since, as he states, it constitutes evidence of specificity, demonstrable by serologic response, characterizing individual members of a single species.

Since we have been called to active service with the armed forces, we do not feel able to continue these observations. We are pointing it out at this time in the hope that it may be helpful to other investigators who are working in this field.

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SCIENCE AND SOCIAL ACTION

THE scientific worker always has a divided personality, and in war-time his symptoms become even more acute. On one hand, he is an internationalist in his

work, using facts and truths regardless of their source and publishing his results for the benefit of mankind as a whole. On the other, he can not help seeing that he belongs to one particular nation and that the fate of this nation has a great deal to do with not only his personal life but the results of his research and teaching.

It is difficult to reconcile these two points of view, and for a student who is just beginning scientific work and still has only the smallest idea of its extent and implications, the problem is almost insoluble. Many such students are, in the experience of the author, abandoning science in favor of active service in the armed forces.

This trend is not particularly the fault of the draft law, which allows men to go ahead in lines of work which are deemed essential to the war effort. In some cases it arises from a desire for a secure future, the student preferring the draft to an uneasy deferment, but in most it appears to be a simple desire to get into the game and to do one's duty as a citizen. Naturally, it is often the most intelligent and responsible students who react in this way. If this situation is a general one—and the author has reason to believe that it is—there will soon be a shortage of scientists and technical men in most fields, and especially in biology and social science. Should the war last a very short time the results will not be serious, but it would be rather optimistic to suppose that the world will settle down to a prolonged peace, even if an armistice is declared within the next two years.

The importance of science in world affairs has often been exaggerated, through a tendency to posthumously canonize able inventors and navigators as scientists, but it is not too much to say that our modern technical civilization would limp along very badly without an adequate number of trained scientific workers. We are not yet in the position which English policy created in the first world war, when not only were the students taken out of the universities, but promising mature research workers were allowed to die in Gallipoli and Flanders. Nevertheless, a weakness in scientific personnel might leave us as severely handicapped for dealing with the post-war problems as the British were in the 1920's.

This may be one of the unavoidable bad effects of war, but it might be partially helped by an attempt to reassemble the split personality of scientist and citizen. In plain words, we should try to find aims common to both, and one rather obvious suggestion follows.

It is the general attitude of thinking citizens that America should play a cooperative and positive role in promoting peace, wealth and happiness in the post-war world, and the scientific worker can materially help to provide means through which that role may be successfully played. In this way scientific research can serve both national and international interests, and every sort of scientist, from anthropologist through physicist to zoologist, can do his part. In many cases he will go on with his regular line of research and teaching.

As far as this proposition is true and acceptable to scientist and citizen, its statement and restatement should help to keep our younger scientific workers and students on the job. If so, what should these citizen-scientists do? It would appear to be a mere matter of common sense that specific research should be done on the problem which has been popularly labeled "winning the peace" and which by its nature would imply research on non-military methods of winning the war. This could be best done on a large scale and in a cooperative fashion, but even the smallest individual step will take us farther on the long road to world harmony.

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A NATURALIST CHARACTERIZES SCIENTISTS

DONALD CULROSS PEATTIE, in a recent review of Beebe's "Book of Bays,"[1] poses the recluse self-centered scientist of sixty years ago as a figure widely prevalent to-day to give emphasis to his approval of Beebe's book, which all in all does not need the support of a false contrast.

Peattie says "few scientists grow broader as they live longer; on the contrary, they tend to groove deeper until, for most of us, they are quite buried from sight at the place where, like sand fleas, they have, as they proudly say, dug themselves in."

This adverse appraisement seems to be the revival of an old quip, oft repeated by clever professors of this and that to the effect that "a specialist was a man who knew more and more about less and less." This was rated as witty or at least humorous, when all sciences were regarded as specialties, illicit, unscholarly, materialistic, and in conflict with religion, art, taste and good manners. The science addict had good reason to be shy in such an atmosphere. Newspapers commented humorously, if at all, on his announced results, and his interest in or approval of any subject made it suspect.

Reviewing a wide acquaintance among scientists I am unable to list a dozen living "sand fleas" among them. Hence I conclude that they are as rare as left-handed snails or as Peatties or Beebes.

D. T. MACDOUGAL

CARMEL, CALIF.

[1] *Sat. Lit. Rev.*, March 14, 1942.

SCIENTIFIC BOOKS

CLINICAL PARASITOLOGY

Textbook of Clinical Parasitology. By DAVID L. BELDING, M.D. xxi + 888 pp. 279 figs. New York and London: D. Appleton-Century Company. 1942. $8.50.

MILLIONS of persons, particularly those in tropical and subtropical regions, suffer from parasitic diseases, and competent observers have maintained that animal parasites cause greater morbidity and mortality than all bacterial infections. The historical record shows clearly that the great epidemics which have decimated populations have been caused by animal parasites or agents transmitted through arthropod vectors. Furthermore, it is the prevalence of such diseases which has in large part prevented the exploitation of some of the richest and most productive areas of the world. Through their colonial interests, the British, Germans, French, Dutch and Belgians have long recognized the importance of parasitic diseases and have developed strong departments of parasitology in their medical schools. Those of London, Liverpool, Cambridge, Hamburg, Paris, Amsterdam and Antwerp are notable examples. Many young physicians went from Europe to the colonies and training in tropical diseases became an essential part of medical education. Several of the leading physicians of Japan and the Orient have studied in one or more of the schools mentioned above and have carried European methods and practices to the Far East.

Until very recently, American physicians have given little attention to animal parasitology, and instruction in the subject at our medical schools has been of the most desultory character. With notably few exceptions, the diseases caused by animal parasites have been considered incidentally in courses devoted primarily to other subjects, such as bacteriology, pathology or public health. Indeed, Dr. Belding's title is professor of bacteriology and experimental pathology. Independent departments of parasitology, staffed by experts, have been absent in American medical schools and much of the fundamental research in the subject has been done by zoologists and veterinarians. The development of aerial transportation, rapid and extensive travel, movements of large military and civilian populations, the search for new sources of essential raw materials, interest in Latin America, and especially the entry of the United States into the present world conflict, have produced a decided awakening of the American medical profession. The realization that parasitic diseases are of major significance and that they are not limited to tropical countries is reflected in the new text-books now appearing. Evidence of the increasing American interest in parasitology is afforded by the recent text-books by Chandler (6th edition, 1940), Craig and Faust (1937), Hegner, Root, Augustine and Huff (1938), Culbertson (1941), Belding (1942), and a forthcoming one by Pearse. These American books, since they differ in the emphasis placed on various aspects of the subject, constitute a valuable addition to the foreign texts. Probably none of them, however, is the equal of Brumpt's "Précis de Parasitologie" in completeness or authoritative presentation. With excellent text-books in the English language now available and with a changed attitude on the part of American physicians, medical students in the United States may expect to receive more adequate instruction in the diseases caused by animal parasites.

The book by Belding is well conceived, logical in organization, and contains a wealth of information. It is well adapted for a general introductory text but has little value for specialists or research workers. It is essentially a compilation of relevant information, although too often the material has been taken from secondary rather than original sources. The publishers have produced other text-books in the same and related fields and many of the figures used in Belding's text have been published previously. This fact does not imply that the book is poorly illustrated; on the contrary, its chief value lies in the arrangement of subject matter and in the diagrams, charts and tabular treatment of data which facilitate comparison of related species, understanding of life cycles and rapid organization of material. The diagnostic characters of species, however, are sometimes too brief for positive identification. French and German sources have not been used to full advantage, latest information is not always included, while the bibliography lists earlier rather than the last editions of such standard text-books as those of Chandler, Manson-Bahr and Mönnig. Belding has presented the essential facts of parasitology, although the treatment of the material is general rather than critical. The first section devotes 12 pages to parasites and 55 pages to general aspects concerning the pathology, immunology, transmission, diagnosis, treatment and prevention of parasitic diseases. These subjects are reconsidered specifically for each parasite in later sections. Section II deals with the pathogenic Protozoa, Section III with nematodes, Section IV with cestodes, Section V with trematodes, Section VI with arthropods and Section VII with technical methods for diagnosis and treatment of parasitic infections. The section on technical methods forms a valuable adjunct to the text and is limited, perhaps wisely, to generally accepted procedures. In the portion dealing with fecal examination for eggs of worms, although the author

lists the Hamburg method for counting ova, he did not mention the Telemann method of stool examination, which is the one routinely used in the Hamburg laboratory. This method was given by Vogel in "Krankheiten und Hygiene der warmen Länder," by Ruge, Mühlens, zur Verth *et al.* (1938), an excellent treatise on tropical medicine which was reviewed in the *American Journal of Tropical Medicine,* 18: 733–34, but was not cited by Belding.

In his "Textbook of Clinical Parasitology," Belding has listed the intermediate and reservoir hosts of the animal parasites of man, but the reviewer is of the opinion that texts on human parasitology could be made clearer and more valuable if comparative material from the study of similar parasites in lower animals were included. Most of the parasites of man can be transmitted to lower animals and probably were acquired from them. Present knowledge concerning human parasites has been obtained, in large measure, from study of the same or related species in non-human hosts. Advances in the control of yellow fever were held back for twenty-five years, until a susceptible experimental host was found in the rhesus monkey. Since the principles and methods of human and veterinary medicine are identical, and since fundamental researches on domestic and laboratory animals have afforded many of the data on which human parasitology is predicated, familiarity with these investigations should be beneficial to medical students.

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REPORTS

METALLURGICAL RESEARCH[1]

DR. FRANK B. JEWETT, president of the National Academy of Sciences, announces the results of eighteen months' operation of the Metals and Minerals Advisory Committee of the academy work of the new War Metallurgy Committee.

The Metals and Minerals Advisory Committee for the past eighteen months has furnished OPM and WPB with 113 reports. Fifty-three of these were on metals substitution and conservation; 47 on ferrous minerals and ferro-alloys; 4 on tin smelting and reclamation, and 9 on non-metallic minerals.

These reports, prepared by the various subcommittees of the Advisory Committee, dealt principally with the problems arising from the necessity for allocation and substitution of materials, not only for general civilian uses, but even more particularly for War Production processes and increased production of war materials.

The work of this Advisory Committee has been greatly enlarged since Pearl Harbor and is to be still further increased as it functions with and for the new War Metallurgy Committee. Clyde Williams, director of Battelle Memorial Institute, Columbus, Ohio, and chairman of the Advisory Committee, is also chairman of the new War Metallurgy Committee which has primarily been set up to appraise and conduct needed research work—for the Army, the Navy and other governmental departments as well as industry.

It is the function of this committee to collect data and information as requested by either the War Production Board or the Office of Scientific Research and Development, through its National Defense Research Committee, and to plan, present and supervise definite research projects for either war materials or armaments.

The War Metallurgy Committee, and its Advisory Committee is set up to function as the nerve center for all metallurgical research organizations and departments in this country—since, depending upon the problem involved, the heads of any business, university or research organization can be counted upon by this committee to make available the experience of their metallurgical scientists and engineers or their laboratory data.

Thus, this committee makes available for the Army and the Navy, through either the War Production Board or the Office of Scientific Research and Development, the services of any or all metallurgical research, personnel and facilities. There are in excess of 10,000 such individuals in this country, and their combined experience represents well over 125,000 man years.

One of the basic considerations in the operation of the committee, is that of the saving of time, the saving of mistakes and the saving of money. When the problem is proposed, through either the War Production Board or the Office of Scientific Research and Development, immediate action can be obtained by telephone communication with the leading scientists on that particular subject; initial committee meetings are often held within twenty-four hours, and, if the request is urgent, within that same day, a plan of procedure is laid down and submitted.

Every one in this country, and scientists and industrialists are no exception, is naturally anxious to contribute everything he can toward winning the war. New thoughts, new ideas, new short-cuts, are constantly coming to the front. While it is not the place

[1] Report of Louis Jordan, executive secretary of the War Metallurgy Committee of the National Research Council, Washington, D. C., June 30, 1942.

of the War Metallurgy Committee to be the repository for such suggestions and ideas, it recognizes as a very definite part of its war-time job the appraisal of such of these problems and possibilities as are referred to it by the War Production Board or the Office of Scientific Research and Development.

Another important function of the War Metallurgy Committee is to digest and make available to those properly interested through their participation in the war effort the results of both Canadian and English metallurgical research. Obviously, both Canada and England have a great many of the same problems which confront us in this country and the interchange of information, through the proper channels, makes available to all the best thinking and practice of scientists and industrialists on both sides of the Atlantic.

Typical of the problems referred to this committee is one asking for improvement in welding processes. A subcommittee was immediately appointed, which collected all available known data from universities, engineering foundations and research departments of business organizations. The Project Section of the War Metallurgy Committee worked up the research indicated, research procedure, and, with the approval of National Defense Research Committee and the Office of Scientific Research and Development, this research was placed with one of the university laboratories and compensated for on a cost basis from funds made available by the Office of Scientific Research and Development.

The time involved in such research projects naturally varies. The report of the subcommittee, on many such projects, is made available within a matter of days, but the project itself may take anywhere from two to six months, depending upon the nature of the research.

Typical of requests for data and projects from the War Production Board is that of the effect of substitution of lead-silver for tin-lead soldering of tin cans used for food products. Since tin is the one important metal which is not found in the United States, even in low-grade ores, it is obviously important that the conservation of the present use of tin is urgent.

Since a great proportion of the total consumption of tin is used in soldering, the substitution of lead-silver for tin-lead soldering is immediately dictated, but the problems involved, in certain canning processes, are such that definite research is needed before such substitution can be ordered.

This research project was prepared through the Project Section of the War Metallurgy Committee and will be administered through its research section, the work being done in one large university research laboratory, in cooperation with the National Canners Association.

SPECIAL ARTICLES

ABSORPTION OF VARIOUS ALCOHOLIC BEVERAGES

IT has long been known that different alcoholic beverages are absorbed at varying rates.[1] Haggard *et al.*[2] have suggested that this may be due to differing buffer capacity.

To investigate this problem, alcohol, Scotch and Bourbon whiskeys, gin and California Port and Burgundy wines were given to two subjects, the final concentration ingested being in all cases 13 per cent. alcohol by volume. The dose in the case of subject A equaled 0.95 gm of alcohol per kgm, in subject B 0.75 gm per kgm. Ingestion was completed, on an empty stomach, in 10 minutes. Venous blood was analyzed for alcohol content.[3] Table 1 shows the maximum alcohol concentrations, the times these occurred and the rate of increment in the first 30 minutes.

In subject A there was a clear-cut difference between the wines and the distilled liquors, the latter being absorbed more rapidly with attainment of a higher maximum. Subject B showed no such difference. He had a distinct aversion to the distilled liquors, resulting in mild nausea, and the explanation offered is that disturbed gastric motility interfered with their rapid absorption. That the two subjects showed no difference in normal gastric motility was demonstrated radiographically after ingestion of colloidal thorium dioxide.

TABLE 1

Subject	Beverage	Maximum Concentration	Time of maximum	Rate of increase first 30 minutes
		mgm per cent.	min.	mgm per cent. per min.
A	Scotch	162	45	5.4
	Alcohol ...	155	45	5.0
	Gin	158	45	4.1
	Bourbon ..	153	45	4.0
	Port	135	120	1.9
	Burgundy .	120	90	1.3
B	Scotch	92	45	2.7
	Alcohol ...	90	75	2.6
	Port	106	60	2.4
	Gin	97	75	2.3
	Burgundy .	85	60	2.0
	Bourbon ..	91	90	1.6

[1] E. Mellanby, Nat. Res. Council (Great Britain) Special Report Series Number 31, 1919.

[2] H. W. Haggard, L. A. Greenberg and L. H. Cohen, *New Eng. Jour. Med.*, 219: 466, 1938.

[3] H. W. Newman, *Jour. Pharmacol. and Exp. Therap.*, 56: 278, 1936.

The initial high peak of alcohol concentration shown by subject A, seen in Fig. 1, is characteristic of rapid

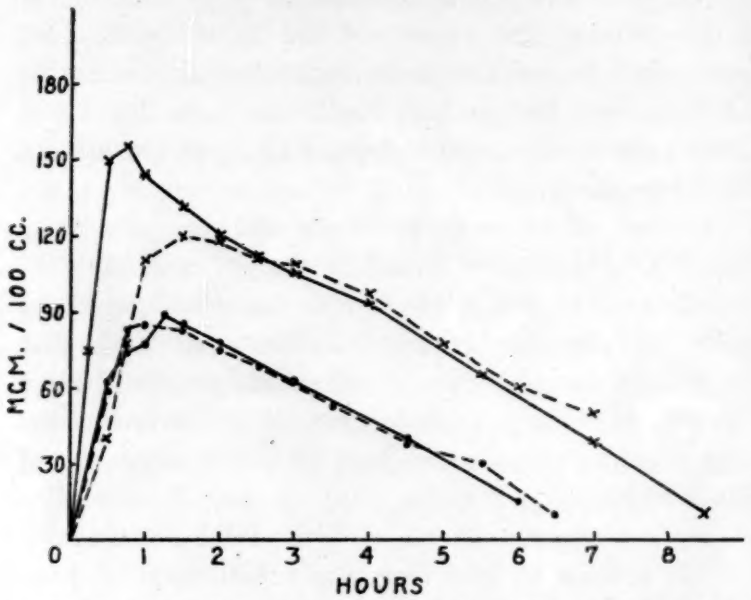

FIG. 1. Blood alcohol concentration following ingestion of diluted alcohol, as shown by the solid lines, and California Burgundy wine, shown by the broken lines. The upper curves are those of subject A, the lower curves those of subject B.

absorption, with failure of equilibration to keep pace. This is notably absent in this subject after the wines.

The same dose of alcohol was again given to subject A, but this time it was buffered to the same pH and buffer capacity as the Port wine. In this case the blood alcohol curve was practically superimposable on that after Port wine, and bore no resemblance to the curve obtained after alcohol alone. Thus there can be no doubt that the slower absorption of wine than distilled liquors is ascribable to its buffer capacity.

CONCLUSIONS

Wines, with their high buffer capacity, are absorbed less rapidly than distilled liquors. This results in the absence of the high peak of blood alcohol concentration seen after ingestion of distilled liquors on an empty stomach. In certain individuals, nausea may so disturb gastric motility as to obscure this difference.

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THE PRODUCTION OF A PRESSOR SUBSTANCE FROM SERUM GLOBULIN BY ACTION OF PEPSIN[1]

THE recent article of H. Croxatto and R. Croxatto[2] has led us to publish some of the work upon which we have been engaged since May, 1941.

The demonstration by Braun-Menendez[3] and others that renin behaves like a ferment led quite naturally to the further study of its ferment-like properties. The discovery by Page[4] that the incubation of blood serum with renin produces a pressor substance, which unlike renin is thermostable, has increased still more the interest in renin and the hypertensive substances which may be formed from or by it.

Our own work followed two lines of investigation. In the first series of experiments, renin was added to various known constituents of serum and the hypertensive effects of the solutions studied on the dog. The substances employed were urea, creatin, creatinin, tyrosin, glycine, histidine, alanine and uric acid in normal saline solution. After incubation for fifteen minutes, the renin solution's activity was destroyed by immersion in boiling water. None of these solutions showed any hypertensive effects. Sheep serum globulin, by contrast, when subjected to the same treatment uniformly gave rise to a pressor substance, called "angiotonin" by Page and "hypertensin" by Braun-Menendez.

In our second series of experiments we studied the effects of various enzymes on serum globulin. We employed trypsin, papain, cathepsin, takadiastase and pepsin. The only positive results were obtained with pepsin, and these results were at first very inconstant. During the past ten months' study of the properties of the pressor substance produced by the action of pepsin on serum globulin, we have learned how to produce this pressor substance with relative ease.

In our experiments we have employed four different commercial preparations of pepsin. The results were identical with each preparation. We have not yet had an opportunity of studying the effect of crystalline pepsin on serum globulin.

The most active pressor substance is produced by incubation between pH 5 and 6 for one-half hour. When more acid reaction such as pH 5, 4 or 3 were employed, the resulting solution was only feebly hypertensive or inactive, or in some instances strongly depressor, possibly because of peptone-like substances, the result of peptic digestion. This observation is in harmony with the fact that pepsin in an acid solution destroys "angiotonin." Incubation for one-half hour produced a much more active preparation than incubation for a shorter length of time.

When the solution of pepsin was immersed in boiling water for ten minutes before addition to serum globulin, no hypertensive substance was formed. Although the hypertensive substance was formed at pH 5–7, it was apparently necessary to dissolve the pepsin

[1] From the Hixon Laboratory for Medical Research, University of Kansas, School of Medicine, Kansas City, Kansas.

[2] H. Croxatto and R. Croxatto, SCIENCE, 95: 101, 1942.

[3] E. Braun-Menendez, J. C. Fasciolo, L. F. Leloir and J. M. Muñoz, *Jour. Physiol.*, 98: 283, 1940.

[4] I. H. Page and O. M. Helmer, *Jour. Exp. Med.*, 71: 29, 1940.

first in 0.1 N hydrochloric acid. The reaction of the serum was then adjusted so that the addition of the pepsin solution would bring the reaction to pH 6–7. The process of incubating serum globulin with pepsin was carried out at 37° C., but it was found that the hypertensive substance was produced also at 20° C.

We employed 2 mg pepsin per cubic centimeter of serum globulin. This solution after 30 minutes' incubation was precipitated with three volumes of alcohol, filtered and the filtrate evaporated *in vacuo*. This residue was then taken up in distilled water in such amounts that one cubic centimeter of the solution was equivalent to one cubic centimeter of the original globulin solution. This solution of the filtrate when injected intravenously into dogs under nembutal anesthesia in doses of 0.1 cc per kilo body weight, produced an average elevation in blood pressure of 22 mm Hg. In many of our experiments the pressor activity of this solution equalled that of renin.[5]

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THE EFFECT OF SYNTHETIC VITAMIN K ON THE RATE OF ACID FORMATION IN THE MOUTH[1]

IN 1939 evidence was found that the reactions involved in the production of lactic actid in the mouth, with subsequent dental caries, are analogous to the reactions involved in lactic acid production in muscle tissue.[2] Furthermore, it has been shown that acid formation in the mouth may be very rapid[3,4] and that a difference between the saliva of caries active and caries immune individuals is the rate of acid formation from sugar in the respective salivas.[5]

On the basis of this it was thought that if some nontoxic substance that would inhibit the chain of reactions involved and thus delay acid formation sufficiently so that the saliva could neutralize them could be found, it could be used to prevent caries.

After an extended search for a product which would fulfil these qualifications, it was found that synthetic vitamin K (2 methyl 1-4 naphthoquinone) was such a substance.

In vitro experiments indicate that a synthetic vitamin K concentration of 1 mg per 100 cc of saliva, 10 per cent. in glucose, forms no acid in a 4-hour incubation period, while the same mixture will produce up to 2 mil. eq. of acid under the same conditions in the absence of the vitamin K.

Preliminary clinical experiments wherein the pH of carious lesions was measured indicate that synthetic vitamin K in the same concentration as in the *in vitro* experiments effectually inhibits acid formation. In the absence of vitamin K the acidity of the lesion may increase from pH 6.8 to pH 4 in as little as three minutes.

The synthetic vitamin K has no effect on the bacterial growth in the concentrations used, so the inhibition is not caused by any antiseptic properties. It has no effect on the conversion of phosphoglyceric acid to pyruvic acid or on the reduction of the pyruvic acid to lactic acid. However, it prevents the formation of phosphoglyceric acid from the hexose phosphates. This indicates that the synthetic vitamin K prevents the dismutation of the hexose phosphate or the conversion of the dismutation products to phosphoglyceric acid.

On the basis of the above it is quite probable that if synthetic vitamin K were incorporated in sugar candy or gum it would effectively inhibit dental caries.

It is interesting to note that vitamin K is probably one of the substances removed from the sugar-cane juice during the purification of sugar.

Clinical and laboratory studies are being continued, and the physiological effects of the ingestion of synthetic vitamin K continuously for long periods of time is being investigated.

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[5] Helmer and Page (*Proc. Soc. Exp. Biol.*, 49: 389, 1942) have verified the work of Croxatto and Croxatto. Our findings differ from theirs in the optimum pH for the production of the pressor substance by pepsin. This may be due to the longer incubation time that we employ.

[1] This investigation was made possible by a grant from the Good Teeth Council for Children.

[2] L. S. Fosdick, *Jour. Am. Dental Asn.*, 26: 415, 1939.

[3] L. S. Fosdick, H. L. Hansen and Epple, *Jour. Am. Dental Asn.*, 24: 1275, 1931.

[4] R. M. Stephan, *Jour. Am. Dental Asn.*, 27: 719, 1940.

[5] L. S. Fosdick, E. E. Campaigne and O. E. Fancher, *Ill. Dental Jour.*, 10: 85, 1941.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFIED WARBURG REACTION VESSEL

WITHIN recent years, the Haldane-Warburg manometric technique has been widely applied,[1,2] and methods based upon the procedure are now commonly used in the routine analytical laboratory.[3,4,5] Despite the many advances in technique, the design of the

[1] M. Dixon, "Manometric Methods as Applied to the Measurement of Cell Respiration and Other Processes." Cambridge, 1934.

[2] D. Burke and R. T. Milner, *Ind. Eng. Chem., Anal. Ed.*, 4: 3, 1932.

[3] A. S. Schultz, L. Atkin and C. N. Frey, *Jour. Biol. Chem.*, 129: 471, 1939; *ibid.*, 136: 713, 1940.

reaction vessel can still be improved. Thus, in the determination of oxygen consumption, the accidental contamination of the contents of the vessel with alkali, which may occur when vessels of the conventional form are used[2,6] and which results in loss of the determination, can be prevented entirely by a slight change in design as indicated in the figure.

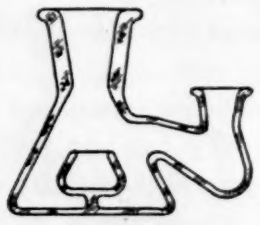

FIG. 1.

A truncated cone-shaped center cup is recommended in place of the usual cylindrical-shaped cup. The center cup in the reaction vessel of Warburg, Kubowitz and Christian[7] has a similar shape, but it is larger and it is fused to the floor of the vessel. By placing the cup on a pedestal 5 to 7 mm high, the absorbing area of the buffered solution below the cup is considerably increased. The vessel constructed as shown in the figure may be rotated rapidly back and forth through an angle of almost 90° from the vertical without any contamination of the buffered solution with the strong caustic alkali absorbent in the center cup.

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SOME NEW USES FOR THE 2 x 2 PROJECTOR

THE advantages of the small projector now used for 2 × 2 slides are quite obvious. They are small, easily handled and less expensive than the older types designed for the standard 3¼ × 4″ slides, and a 200 or 300 watt bulb gives good brightness. Besides this, many photographers will welcome the ease of making Kodachrome slides with a miniature camera.

These considerations have led me to experiment with microscopic objects of fairly large size, both in sections and whole mounts. Cross sections of an embryonic dogfish fixed to a 2 × 2 slide and suitably stained serve to show the relationship of such structures as gills, notochord, neural tube and myotomes. The brook lamprey is another promising subject, and different types of plant stems show up beautifully on the beaded screen.

Whole mounts of a wide variety of subjects may be used, from feathers to chick embryos or insects with spread wings and legs. Small leaves, cleared or skeletonized to show the veining, should offer a promising field to botanists, and I am starting some work along these lines.

In mounting material I have used the ordinary histological techniques for the most part, but prefer thin sheet plastic to glass for cover slips because it can be cut to cover the entire slide, leaving no edges to catch when filing slides. I have mounted a few sections between two sheets of this, putting them in pasteboard "Ready Mounts," but for most purposes a glass slide is preferable.

The limitations of the method are obvious. The usual mask supplied measures 23 × 33 mm, and nothing much larger than this can be used. It must also be plain that histological details seldom show up clearly because of the low magnification, but gross anatomical structures, like xylem and phloem or annual rings, can be seen perfectly. I have not yet tried making a water cell to use with living material like small tadpoles, algae or crustacea, but that should be practical.

In order to try some of the microscopic material in our slide collection I made a slide carrier of wood to take microscopic slides. While this is workable the dimensions of the 1 × 3″ slide make it much harder to handle than the 2 × 2. Furthermore, unless this type of slide is used exclusively the frequent changing of carriers is a nuisance. For these reasons I am making a series of 2 × 2 slides for use in the department.

At least one supply house is making 2 × 2 Kodachrome slides from stained histological material, a method that gives beautiful results with a wide variety of subjects and at a reasonable cost.

The arc lamp projector that sends a strong beam through a microscope unquestionably gives much better results for histology, but it is an expensive and cumbersome apparatus and needs complete darkness to give satisfactory results, while the 2 × 2 projector is portable, easily operated and shows any fairly transparent material in enough light for students to take notes.

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[4] R. Goodhart and H. M. Sinclair, *Jour. Biol. Chem.*, 132: 11, 1940.
[5] W. R. Johnston and C. N. Frey, *Ind. Eng. Chem., Anal. Ed.*, 13: 479, 1941.
[6] O. Warburg, E. Negelein and W. Christian, *Biochem. Zt.*, 214: 26, 1929.
[7] O. Warburg, F. Kubowitz and W. Christian, *Biochem. Zt.*, 242: 170, 1931.

BOOKS RECEIVED

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